DOCUMENT RESUME

ED 061 081 SE 013 514

AUTHOR Schoen, Harold L.
TITLE A Comparison of Four Types of Feedback to Student Responses on a CAI Unit Designed to Teach the Concept of Function.
PUB DATE Apr 72
NOTE 13p.; Paper presented at the National Council of Teachers of Mathematics Annual Meeting (50th, Chicago, Illinois)

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS Achievement; Algebra; Attitudes; College Mathematics; *Computer Assisted Instruction; *Feedback; *Individualized Instruction; *Mathematics Education; *Research

ABSTRACT

This study compared four instructional treatments which differed in the degree of individualization and personalization in a computer assisted instructional unit designed to teach the concept of function. The researcher developed two units and adapted the second for four types of feedback: two levels of individualization to incorrect responses and two levels of personalization throughout the instruction. The instruction lasted an average of 171 minutes, during which three achievement tests were administered, one after the first unit (a dummy run intended to minimize the Hawthorne effect) and one after each subunit of the experimental unit. An attitude test was also given at the end of the course. The results of an analysis of variance showed inconsistent significance of treatment effects, but students seemed pleased at the use of their first names during the instruction. (MM)

A COMPARISON OF FOUR TYPES OF FEEDBACK TO STUDENT RESPONSES ON A CAI UNIT DESIGNED TO TEACH THE CONCEPT OF FUNCTION

Harold L. Schoen

Assistant Professor of Mathematics and Education
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

There is a movement in education today to individualize instruction; that is, to somehow fit a student's education to his needs and interests. Few educators would argue against the desirability of this general goal. The major sources of disagreement concerning this issue stem from the lack of a uniform definition of "individualize" and the apparent inability to develop satisfactory methods of achieving the goal once it is defined.

This study compared four instructional treatments which differed in the degree of individualization and personalization (references to the student by name) in a computer assisted instruction (CAI) unit designed to teach the concept of function. Mean achievement and attitude scores of groups of college pre-calculus students receiving the different treatments were compared.

Background

Proponents of CAI see it as one approach to individualization of instruction and as a very useful research tool (Hatfield, 1969). This

---

This paper is a report of the author's doctoral dissertation conducted under the direction of Dr. F. Joe Crosswhite, Ohio State University.

last claim is based on the capability of the computer for storing and manipulating data. However, the question of how individualization of instruction via CAI can best be achieved is "an almost untouched problem" (Gentile, 1967). Furthermore, CAI's full research capabilities have not as yet been utilized. The following indicates one reason.

> While many (CAI) studies have been conducted . . . in many of them, the Hawthorne effect of novelty may be the overwhelming factor (Grayson, 1970).

Research has been done in the area of individualization, including some studies in which CAI was used. In a programmed learning study some subjects were given review following an incorrect response while others were only given the correct answer. No evidence of significant differences in achievement scores was found (Merrill and Stolurow, 1966). In another study, no significant differences in learning or retention were found among groups receiving five different types of feedback on a CAI unit which taught science concepts to university upper-classmen (Gilman, 1967; Gilman, 1969). No significant differences were also found in a study comparing two modes of CAI feedback with a conventional classroom approach (Proctor, 1969). The relative effect of verbal definitions and numerical examples as corrective feedback in a computer assisted learning task for ninth graders was investigated by Kents and Hansen (1970). Results favored the use of verbal definitions.

In summary, the literature indicates that there is a need for researching methods of individualizing instruction. At least some people feel CAI can serve as a tool for researchers in this area. However, one major problem which must be overcome in a study using CAI is the Hawthorne effect of

novelty. Past research does not yield any clearly superior approaches to individualization, either via CAI or otherwise.

Method

Two CAI units were developed by the researcher - Unit A, including concepts pre-requisite to functions such as sets, ordered pairs, and graphs; and Unit B, containing the definition of function, graphs of functions and functional notation. Unit A and Unit B are available on one of The Ohio State University's I.B.M. 360/50 computer systems. They were written in I.B.M. Coursewriter III, version 2, and were administered via I.B.M. 2741 teletype terminals. Four types of feedback to incorrect student responses were written in Unit B. These are the result of crossing two levels of each of two variables, I (individualization) and P (personalization).

The levels of I were defined as follows.

I' - the student receives feedback following an incorrect response which states why his answer is incorrect and gives the correct response.

I'' - the student receives feedback following an incorrect response which states that the given answer is incorrect and gives the correct answer with a reason why it is correct, but the feedback does not refer specifically to the student's response.

The feedback to correct student responses was the same for the two levels of I. The lengths of the feedback statements for the two levels were as nearly equal as possible.

The levels of P are defined as follows.

P' - the student's first name appears in some of the feedback to both correct and incorrect responses. The frequency of use of the first name was decided by what seemed reasonable to the researcher. The only pattern followed for use of the first name was that if the name was used in feedback to one response to a question it appeared in feedback to any response to that question. Hence, the student's error rate did not affect the frequency with which his first name appeared. To be exact, the name appeared in feedback to responses to 41 of the 56 questions in Unit B.

P'' - the student's name never appeared in the feedback. The four types of feedback then were I'P', I'P", I"P' and I"P" which result from crossing the two levels of I with the two levels of P.

As an example of the type of feedback for each group, suppose this question is asked the subject.

So in the previous question, S = [(x,y): y = 2x + 3 and x = 1, 2, or 3] is a function.

a. whose domain is [9, 7, 5] and whose range is [1, 2, 3].
b. whose domain is [1, 2, 3] and whose range is [5, 7, 9].
c. whose domain is x and whose range is y = 2x + 3.
d. none of the above.

If the student response is c then the I'P' feedback is:

x is only a symbol representing the values in the domain and y, those in the range. The correct answer is b, Alice.

The I'P" feedback is the same except 'Alice' is omitted.

The I"P' feedback is:

> No, the domain is the set of values x (or the first coordinate) may take, so the domain is [1, 2, 3]. The range is the set of y values so y = 2x + 3 has values 2(1) + 3 = 5, 2(2) + 3 = 7, and 2(3) + 3 = 9. The correct answer is b, Alice.

The I"P" feedback is identical except 'Alice' is omitted. Feedback for the two I groups is the same for any incorrect response; that is, c, a, or d.

The CAI units were based on a set of researcher developed behavioral objectives which followed the recommendations of several authors (Bohein, 1968; Gagne, 1964; Gagne and others, 1965; Krathwohl, 1964; Lindvall, 1964; Mager, 1962; Tyler, 1964; Ullmer, 1967). The branched programmed CAI units were designed to lead the students to achieve the behavioral objectives. The instructional approach was a form of guided discovery in that a series of motivational questions and information were given the students prior to defining a concept. Three achievement tests, Q, R, and S, and an attitude scale, T, were developed (twenty items of the thirty-item attitude scale were used with permission of Carlton Robardey, Michigan State University). Two pilot studies for purposes of revising and refining the instructional units and evaluation instruments preceded the final study. Q was a twenty-item test of Unit A, R was a fifteen-item test of Unit B, subunit 1 (the definition of function), and S was a fifteen-item test of Unit B, subunit 2 (functional notation). Q, R, and S were composed of multiple choice items. The number of items and the materials tested by each instrument were decided based upon pilot data.

Sixty pre-calculus methematics students at The Ohio State University in the Winter Quarter, 1971, were the subjects. They comprised two sections of Math 150 (students are placed into sections at Ohio State from a shuffled deck of class cards). The subjects were then placed randomly in equal numbers into the four treatment cells. During the first three weeks of the quarter all subjects were administered Unit A followed immediately by Test Q, then Unit B, subunit 1, followed immediately by Test R, and finally Unit B, subunit 2, followed immediately by Test S, all via an I.B.M. 2741 terminal. Two days after all subjects received the computer treatment, they completed T, the attitude scale, using pencil and paper. The Unit A treatment was included prior to the instructional unit on which the experimental comparisons were made (Unit B) in order to decrease the Hawthorne Effect of novelty. The Unit A treatment was identical for all four treatment cells.

The null hypotheses of no differences between mean scores of the combined group I'P' and I'P" compared with the combined group I"P' and I"P" and of no differences between mean scores of the combined group I'P' and I"P' compared with the combined group I'P' and I"P" on each of the criterion measures R, S, and T were posed. Nearly equal cell means prompted eliminating the use of Test Q scores as a covariate. Thus the hypotheses were tested using two-way analyses of variance with R, S, and T scores as the respective dependent variables. The BMD05V program for testing general linear hypotheses was used.

RESULTS

The results of the main comparisons are summarized in the following table.

(Insert table here)

Using R scores as the dependent variable the I effect is clearly non-significant, but the P effect is significant with p less than .11. With the small N in each cell, this may be an indication of some differences in the levels of P; namely, that the P' groups, those receiving feedback with student names included, tended to perform better than the P" group on R.

The results of the analysis of variance using S scores as the dependent variable indicate that students receiving the I" treatment scored higher (p less than .04). This is in contrast to nearly equal means on the R scores for the two groups. Analyzing the P effect shows that the P' group, those receiving their names in feedback, scored higher than the P" group, though not significantly higher. The reliability of the fifteen-item Test R was estimated by KR - 20 = .70 (N = 60).

To analyze the T (attitude) scores, student responses were coded from 0 to 4 with a higher score indicating a more positive attitude. The results in the Table are based on student scores computed by taking the sum of the coded student response for each of the thirty items. Using correct to mean a 3 or 4 on an item and incorrect to mean a 0, 1, or 2, the reliability of this thirty-item instrument was estimated by KR - 20 = .84, where N = 58. Here N is 58 instead of 60 because two subjects dropped the course before the administration of T. The

attitude scores of students receiving the P' treatment are higher than those receiving the P" treatment at the .07 probability level, while the I effect is clearly non-significant.

Further analysis showed non-significant correlations between attitude and achievement scores. Mean student CAI treatment time was 171.07 minutes. This includes the time taken to complete Unit A and Unit B as well as tests Q, R, and S. Student time did not differ significantly among the treatment cells.

Conclusions and Implications

The results of this study do not suggest that the type of individualized feedback (I') written for this program yields better student achievement or attitude scores than non-individualized feedback (I"). In fact, on one achievement test, scores were significantly higher in the I' group, while no significant differences were found in the other achievement test scores or the attitude scores. These results were obtained using CAI, but if they can be generalized to other modes of instruction such as programmed learning, homework, and even teacher-student classroom interaction, their implications are startling.

Student achievement, according to the results, is greater if, instead of explaining a student's error to him, the teacher or program simply gives him the correct answer with an explanation of why it is correct. There was also no evidence in this study to indicate that the students preferred one approach over the other. Admittedly, the results must be generalized beyond the mode of instruction (CAI), the target population (pre-calculus students), and the topic of instruction (the concept of function) to draw these conclusions.

The use of a student's first name seemed not only pleasing to him (attitude difference at p less than .07), but there was also some evidence that better achievement occurred when the first name was used. These results imply that students, as probably most human beings, do respond positively to being referred to by name. This is not a surprising result though in the classroom as in CAI programs it is not always put into practice.

This positive correlation between Unit B time and attitude scores seem to indicate that the students who enjoyed the program most did not hurry to finish, while those who disliked it rushed through. The result may be caused by a few students who became frustrated because they did not understand the explanation or were simply tired.

Discussion

The findings of one study using one mode of instruction (CAI), one instructional program and a sample of 60 students are a small contribution to educational research. Much more research in the area of individualization is needed. Studies using other populations, modes of instruction, and treatment levels should be done.

Some related research is presently being planned. For example, research has been proposed by Kenneth Taylor, a graduate student at The Ohio State University, which will essentially replicate the design of this study, but use a different CAI program and a different population. His program will teach geometric concepts to college seniors.

The researcher also plans to follow this study with an expansion of the feedback treatments. A combination of the I' and I" feedback is

planned, adding a third level to the individualization variable. It is hoped that this follow-up study can be done with a sample of high school juniors and seniors, since younger populations will allow the results to be generalized to greater numbers of students.

Another follow-up to this study is presently being conducted at Virginia Polytechnic Institute. Employing a research design and feedback treatments similar to those defined in this study, the investigator is varying written feedback on lab exercises to groups of elementary education mathematics students. A comparison of achievement, retention, and attitude scores should give some indication of the generality of this study's results to other modes of instruction. The data have been collected but have not been analyzed at this time.

References

Bohien, J. O. Implications for the individualization of instruction for curriculum and instructional design. Audiovisual Instruction, 1968, 68, 13, 238-242.

Gagne, R. M. The implications of instructional objectives for learning. In C. M. Lindvall (Ed.), Defining Educational Objectives. Pittsburgh, Pa: University of Pittsburgh Press, 1964.

Gagne, R. M. and others. Psychological principles in system development. New York: Holt, Rinehart and Winston, Inc., 1965.

Gentile, J. R. The first generation of CAI systems - an evaluation review. AV Communication Review, 1967, 15(1), 23-54.

Gilman, D. A. Comparison of several feedback methods for correcting errors by computer-assisted instruction. Journal of Educational Psychology, 1969, 60, 503-508.

Gilman, D. A. Feedback, prompting, and overt correction procedures in nonbranching computer assisted instruction programs. Journal of Educational Research, 1967, 60, 423-429.

Grayson, L. P. A paradox: the promises and pitfalls of CAI. EDUCOM, 1970, March, 1-3.

Hatfield, L. L. Computers in mathematics instruction. Studies in Mathematics, 1969, 19, 129-153.

Keats, J. B., and Hansen, D. N. Definitions and examples as feedback in a CAI stimulus-centered mathematics program. Unpublished manuscript, Florida State University, 1970.

Krathwohl, D. R. The taxonomy of educational objectives - its use in curriculum building. In C. M. Lindvall (Ed.), Defining Educational Objectives. Pittsburgh, Pa: University of Pittsburgh Press, 1964.

Lindvall, C. M. The importance of specific objectives in curriculum development. In C. M. Lindvall (Ed.), Defining Educational Objectives. Pittsburgh, Pa: University of Pittsburgh Press, 1964.

Mager, R. F. Preparing instructional objectives. Palo Alto, California: Fearon Publishers, 1962.

Merrill, M. D., and Stolurow, L. M. Hierarchical preview versus problem oriented review in learning on imaginary science. American Educational Research Journal, 1966, 3, 251-261.

Proctor, W. L. A comparison of two instructional strategies based on computer-assisted instruction with a lecture-discussion strategy for presentation of general curriculum concepts. (Doctoral dissertation, Florida State University) Dissertation Abstracts, 1969, 29, 2075-A. (Abstract)

Tyler, R. W. Some persistent questions on the defining of objectives. In C. M. Lindvall (Ed.), Defining Educational Objectives. Pittsburgh, Pa: University of Pittsburgh Press, 1964.

Ullmer, E. J. A study in the development of a technology based model for instruction design. (Dcotoral dissertation, University of Wisconsin) Dissertation Abstracts, 1967, 28, 4551-A.

TABLE

SUMMARY OF THE ANALYSIS OF VARIANCE ON THE POST-TEST MEASURES

Measure	I LEVEL	cell means & S.D. P' Mean	P' S.D.	P'' Mean	P'' S.D.	F I	F P	F I x P	Probability I	Probability P	Probability I x P
R	I'	9.87	2.36	8.60	2.59	0.011	2.596	0.184	.91	.11	.67
	I''	9.53	2.03	8.80	2.60						
S	I'	9.20	2.68	7.73	3.08	4.501	0.736	1.273	.04	.39	.26
	I''	9.93	2.76	10.13	2.70						
T	I'	79.50	14.86	75.73	13.31	0.389	3.395	0.600	.55	.07	.45*
	I''	84.43	6.99	75.20	16.34						

*degrees of freedom are 1, 54 on T and 1, 56 on R and S.